

Massachusetts Institute of Technology
C. S. Draper Laboratory
Cambridge, Massachusetts

LUMINARY Memo #227

To: Distribution
From: Luminary Test Group
Date: 13 July 1971
Subject: Level 6 Test of DSKY Keystroke Backup Erasable Program
for LUMINARY 1E

This memo summarizes the results of the Level 6 Test 6.5.7, which was run to verify proper operation of the Erasable DSKY Keystroke Backup Program during Descent to Lunar Surface, APS Abort, Rendezvous Navigation, CSI and an RCS P41 Burn. The test assumed an ENTER key failure prior to the selection of P63.

The initialization of this test is as follows:

- (1) 1σ IMU, Radar, State Vector Errors
- (2) Normal Astronaut interface from Apollo 15 Data File
- (3) Apollo 15 Operation Trajectory
- (4) Apollo 15 Erasable Load
- (5) DSKY Keystroke Erasable Program Pad Loaded
- (6) 71/72 Ephemeris
- (7) 10% TLOSS
- (8) LM-10 Vehicle
- (9) Terrain Profile $+1^{\circ}$ Error

TEST 6.5.7 DSKY KEYSTROKE BACKUP TEST

I. Test Objective

Verify operation and performance of the DSKY Keystroke Backup Erasable Program during Descent to Lunar Surface, APS Abort, Rendezvous Navigation, CSI and an RCS P41 burn.

II. Test Description

This test is run with the ABORT Discrete present. An ENTER keystroke will be done using the Engine Gimbal Enable switch. The keystroke backup program, which is described in LUMINARY Memo 224, is pad-loaded.

Program Sequence

P00 Idle Program

V48 DAP Data Load Routine (R03)

Set abort channel backup

V72 Uplink to enable ENTER button backup

P63 Braking Phase Program

V57 State Vector Update Routine; LR Update (R12)

P64 Approach Phase Program

P66 Vertical Phase Program (R. O. D. - Auto)

Abort Stage

P71 APS Abort Program (after Touchdown)

P00 LGC Idling Program

V64 S-Band Antenna Program (R05)

V82 Orbital Parameters Display Routine (R30)

V83 Rendezvous Parameters Display Routine (R31)

P20 Rendezvous Navigation Program

P32 Coelliptic Sequence Initiation Program

P41 RCS Burn Program

While in P71, the following exercises will be performed:

- I. Manual yaw maneuver to observe vehicle attitude control response to ACA when mode control is ATTHOLD.
- II. Monitor N76, N77, N85 via V16.

General Summary

During the descent phase the following trim gimbal commands were lost because of cycling the trim gimbal enable switch OFF/ON to cause an ENTER keystroke.

Time	Trim Gimbal Commands Lost
376383	- Pitch - Roll
376410	- Pitch + Pitch + Roll - Pitch - Roll
376472	+ Roll - Pitch + Pitch - Roll + Pitch - Pitch - Pitch

Examination of E-Memory after the test sequence showed the DSKY Keystroke Backup Program to be unaltered. This test registered no downrupt losses and there were no alarms or other off-nominal signals. A maximum of 4 VAC areas were used at any one time.

DIGITAL AUTOPILOT PERFORMANCE SUMMARY

This edit covers period 376127 - 377283 seconds.

The ABORT backup bit was set in the DAP data load.

376136	IGNITION (P63), ABORT button pushed.
376181	ATT HOLD, Manual yaw (50° at $5^\circ/\text{sec}$), AUTO
376699	Highgate - P64 entry
376854	TOUCH DOWN
376858	ABORT-STAGE, ATT HOLD (LIFTOFF)
376864	P71 entry, AUTO
376941	ATT HOLD, Manual yaw (-36° at $-10^\circ/\text{sec}$), AUTO
377294	ENGINE OFF

The descent engine gimbal was disabled for 0.5 seconds and then re-enabled, as the erasable DSKY Backup was used. This occurred in Descent at 376383, 376410, and 376472. In the occurrence at 376410, the delta-V monitor in SERVICER stopped DAP control of the engine gimbals for 2 seconds (the period between SERVICER passes) when it sensed the "ENGINE GIMBAL OFF" bit. No control problems resulted, since control is simple during this period of the descent, but attitude error responses of $\leq 1^\circ$ were observable. During ascent, the disabling of the gimbals was exercised several times with no discernible effect on the DAP control.

P-axis: The descent manual yaw rate peaked at $5.2^\circ/\text{sec}$, the ascent manual yaw rate peaked at $-11^\circ/\text{sec}$. Liftoff transient rates were $\pm 1.8^\circ/\text{sec}$. Attitude errors were under $\pm 1.25^\circ$ throughout.

- Q-axis: The P71 ascent pitch-forward reached a max rate of $-16.8^\circ/\text{sec}$, and the P64 pitch-over rate peaked at $-11.4^\circ/\text{sec}$. P64 attitude error reached -9.1° . The pitch control was normal both in descent and in ascent.
- R-axis: Lift-off transient roll rate peak was $9^\circ/\text{sec}$, and the attitude transient was 5.1° . Roll control was normal, both for descent and for ascent.

Test Results Summary

DESCENT

	AGC	ENV
<u>Ignition</u>		376137 secs
Altitude		
Yaw		-51.05 degs
Pitch		-176.23
Roll		-0.71
V57: Time		376383 secs
Altitude	40733	33634 ft
Alt-Rate	-60.8	-61.5 ft/sec
Deltah	-4101	
<u>Throttle down</u>		376585 secs
Thrust		5706 lbs.
Altitude *	24489	12367 ft
Alt-rate	-86.2	-90.2 ft/sec
<u>Highgate</u>		376700 secs
Altitude	7807	7573 ft
Alt-Rate	-184.4	-185.0 ft/sec
V-horiz.	266.2	270.8 ft/sec
<u>Low Gate</u>		376822 secs
Altitude	198	219 ft
Alt-Rate	-6.3	-6 ft/sec
V-horiz.	5.5	5.2 ft/sec
<u>Touchdown</u>		376854 secs
Alt-Rate	-6.6	-6.4 ft/sec
V-horiz.	.1	.4 ft/sec

*Note: AGC Altitude is wrt landing site, ENV Altitude is wrt local terrain.

Navigation errors

R_x	-8 meters
R_y	-2037
R_z	-1065
V_x	-.04 m/sec
V_y	.02
V_z	-.12

	AGC	ENV
Abort Stage		

Insertion

Apolune	69. 8	72. 1 n. mi
Perilune	9. 7	9. 7 n. mi.
Altitude	60283	55815 ft
Alt-Rate	24. 5	27. 6 ft/sec
VGX Body	-. 3 ft/sec	
VGY Body	-1. 1 ft/sec	
VGZ Body	2. 3 ft/sec	

RCS Burn (P41)

Ignition	380620 sec
VGX Body	44. 7 ft/sec
VGY Body	. 2
VGZ Body	-. 2

P41 Insertion

VGX Body	-. 1 ft/sec
VGY Body	. 0
VGZ Body	. 0